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ABSTRACT

This teacher's guide presents teaching suggestions and presentation materials about the importance of biodiversity, examines why it is threatened, and suggests ways of conserving it. The lesson is divided into seven parts and suggests allowing two or more class periods for completion. Student handouts include: (1) "Test Yourself: How Much Do You Know about Biodiversity?"; (2) "Facts about Biodiversity"; (3) "Collecting Species Data in Costa Rica"; and (4) "Answers to 'How Much Do You Know about Biodiversity?'" Transparency masters are titled: (1) "Species Remaining to be Described"; (2) "Wetland Loss in Selected Industrialized Countries, 1950-80"; (3) "Trends in Deforestation and Population Growth, 1850-1980"; and (4) "Tropical Areas with Rich Floral Diversity." (EH)

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# TEACHER'S GUIDE

## To World Resources

# Biodiversity

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# Teacher's Guide

# to

# World Resources:

# Biodiversity

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# Teacher's Guide

# to

# World Resources:

# Biodiversity

Comprehensive Coursework on the
Global Environment

World Resources Institute
1709 New York Avenue, N.W., Washington, DC 20006

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# Using World Resources Teacher's Guide Units

World Resources *Teacher's Guide* Units are designed for use at the secondary school level (although we have reports of successful use at the middle school and college levels). They weave together lessons about both environment and development, both globally and locally. They draw on skills and knowledge from the physical and biological sciences, social studies, history, economics, civics, and global studies.

Information and analysis used in the Units are drawn from World Resources Institute (WRI) publications and databases. All units are written by curricula writers and reviewed by educators as well as by technical experts. The Units are updated and revised periodically based on feedback from classroom teachers who have used the materials.

Our intent is to provide easy-to-use, inexpensive classroom materials that contain the most recent and authoritative information on the global environment because we believe it is crucial that the next generation of leaders and citizens understand the issues described here.

The complete set of *Teacher's Guide* Units includes the following topics:

- Biodiversity
- Car Trouble
- Citizen Action
- Energy, Atmosphere, and Climate
- Natural Resource Economics
- Oceans and Coasts
- Population, Poverty, and Land Degradation
- Sustainable Development
- Two Giants: China and India
- Watershed Pollution
- Women, Equity, and Sustainable Development

These units have been revised and updated with the most recent data available as of spring 1994.

## Inside Each Unit

Each *Teacher's Guide* Unit should contain enough teaching suggestions and presentation materials to teach one to several classes on the topic without securing additional resources. On the other hand, each unit is designed to point teachers and students to additional resources and to offer suggestions for expanded coursework. Specifically, each unit contains objectives, a lesson plan, student handouts, overhead transparency masters, student enrichment activities, suggestions for further reading, and suggested audiovisual resources.

## Using the Units for Environmental Studies

The *Teacher's Guide* Units provide a comprehensive, consistent yet highly flexible set of materials for environmental studies courses. They can be used in conjunction with an environmental science textbook to give students an understanding of basic environmental systems and cycles. Or they can be used in a social studies context to examine some of the tough problems and choices we face as a society.

Educators who want to go beyond the *Teacher's Guide* Units can read related WRI publications, which provide the basic data, source materials, and analysis for the Units. These publications are listed at the beginning of each unit. A free catalog can be obtained by calling 1-800-822-0504.

## Integrating Teacher's Guide Units into the Curriculum

Secondary school teachers frequently mention the difficulty of integrating environmental issues into a tightly packed curriculum. As much as they would like to teach about the environment, they must devote class time to required subjects.

To help them place these issues in their curricula, we have coded each lesson plan and each student enrichment activity to the draft national performance assessment standards for science, math, history, civics, and geography. These standards are being developed as part of the national Goals 2000 program in the U.S. Department of Education. The standards themselves are being developed, discussed, and revised by educational organizations in nine academic disciplines. They are expected to be approved at the national level, then offered to states to incorporate into their own academic assessment plans. Although this process will take several years, we have compiled lists of assessment standards for grades 9 through 12 from drafts available in spring 1994 to offer some guidance to teachers.

A complete list of the draft standards for Grades 9 through 12 appears in Appendix B, which should be mailed to you with your order. Appendix A provides a bibliography and list of related organizations.

# Integrating Global Environmental Education into High School Curricula

In an effort to link lessons about global environment and development issues to required school curricula, we have identified which pages of the lesson plan and which student enrichment activities in this *Teacher's Guide* Unit relate to the draft national performance standards developed recently for civics, geography, history, math, and science in grades 9 through 12.

These voluntary national standards are part of the Goals 2000 program mandated by the Goals 2000: Educate America Act of 1994 under the direction of the U.S. Department of Education. Among other things, Goals 2000 will establish a set of goals or performance standards for grades 4, 8, and 12 in the subjects listed above plus English, the arts, and foreign languages. These goals will be available to the states for incorporation into their own sets of educational performance standards. Each set of draft standards was developed by a professional education organization and has been presented at numerous educational conferences for review and comment. The draft standards used here are those available as of spring 1994.

Although many countries have national performance standards, the United States (and Canada) have treasured a decentralized educational system that sets education goals at the district or state level. Goals 2000 is the first attempt to identify a set of general education objectives that all students in the country are expected to achieve. As might be expected, there is some controversy over whether there should be national education goals—even voluntary ones—and if so, what they should be.

Regardless of the final outcome, we feel the draft goals do reflect some consensus among educators about what material should be covered at various grade levels, and as such, offer some guidance for integrating environmental education into the curricula.

Only those goals relevant to this unit are listed here. A complete list of goals appears in the 1994 *Teacher's Guide to World Resources*. Copies of reports outlining the goals for each subject area can be obtained from the education organizations listed at the top of each set of goals on this page. Information about the Goals 2000 program is available at 1-800-USA-LEARN.

## Goals 2000: Draft National Performance Standards

### Civics & Government*

*(Draft National Standards, October 1993, Center for Civic Education, 5146 Douglas Fir Road, Calabasas, CA 91302-1467)*

| | Lesson Plan | Enrichment Activity |
|---|---|---|
| **III. How Does the Government Established by the Constitution Embody the Principles and Purposes of American Democracy?** | | |
| 2. What does the national government do and how can it be influenced? | 9 | |
| 3. How are state and local governments organized, what do they do, and how can they be influenced? | 9 | |
| **V. What are the Roles of the Citizen in the American Political System?** | | |
| 4. How can citizens participate in public life? | 9 | |
| C. Forms of political participation. | 9 | |
| E. Knowledge and participation. | 9 | |

### History*

*(Draft National Standards, October 1993, National Center for History in the Schools at UCLA, 231 Moore Hall, 405 Hilgard Avenue, Los Angeles, CA 90024)*

| | Lesson Plan | Enrichment Activity |
|---|---|---|
| **III. Historical Interpretation** | | |
| 4. Consider multiple perspectives in the records of human experience, by demonstrating in what ways the differing, motives, beliefs, interests, hopes, and fears people brought to the issue influenced their behaviors. | | 4 |
| **IV. Historical Analysis** | | |
| 4. Demonstrate and explain the influence of ideas, human interests, beliefs and ideologies on individual and group historical actions and their consequences. | | 4 |
| 5. Hypothesize the influence of the past on the present. | | 4, 7 |

*Note: Only the education goals relevant to this unit are listed.*

## Geography*

*(Draft National Standards, October 1993, National Council of Geographic Education, Geography Standards Project, 1600 M Street, NW, Washington, DC 20036)*

| | Lesson Plan | Enrichment Activity |
|---|---|---|
| **I. Seeing the World in Spatial Terms** | | |
| 1. Knows and understands how to use maps, globes, and other graphic tools and technologies to acquire, process, and report information from a spatial perspective. | 2 | 3, 7 |
| **IV. Human Systems** | | |
| 9. Knows and understands the characteristics, distribution, and migration of human populations on Earth's surface. | | 4 |
| 10. Knows and understands the nature and complexity of Earth's cultural mosaics. | | 4 |
| 11. Knows and understands patterns and networks of economic interdependence on Earth's surface. | 3, 6 | 4 |
| 12. Knows and understands the processes, patterns, and functions of human settlement. | 6 | 4 |
| **V. Environment and Society** | | |
| 16. Knows changes in the meaning, distribution, and importance of resources. | | 4, 7 |
| **VI. Applying Geography** | | |
| 17. Knows and understands how to apply geography to interpret the past. | | 4 |

## Mathematics*

*(Draft National Standards, March 1989, The National Council of Teachers of Mathematics, Order Processing, 1906 Association Drive, Reston, VA 22091)*

| | Lesson Plan | Enrichment Activity |
|---|---|---|
| **I. Mathematics as Problem Solving** | | |
| 2. Apply integrated mathematical problem-solving strategies to solve problems from within and outside mathematics. | | 2 |
| **II. Mathematics as Communication** | | |
| 3. Express mathematical ideas orally and in writing. | | 2 |
| **X. Statistics** | | |
| 1. Construct and draw inferences from charts, tables, and graphs that summarize data from real-world situations. | 4 | |
| **Mathematics—*continued*** | | |
| 4. Understand sampling and recognize its role in statistical claims. | | 2 |
| **XI. Probability** | | |
| 1. Use experimental or theoretical probability, as appropriate, to present and solve problems involving uncertainty. | 5 | |

## Science*

*(Draft National Standards, February 1994, National Academy of Sciences, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418)*

| | Lesson Plan | Enrichment Activity |
|---|---|---|
| **I. Science As Inquiry** | | |
| 2. Design and conduct full scientific investigations and communications. | | 2, 6 |
| **III. Life Science** | | |
| 1. Biodiversity | 2-9 | 1-10 |
| 3. Genetics and Molecular Biology | 4 | 1, 5 |
| 4. Ecosystems and Human Ecology | 2-7 | 2-4, 7 |
| 6. Growth, Development, and Differentiation | | 6, 8 |
| 7. Maintenance of a Dynamic Equilibrium | 7 | |
| **V. Unifying Concepts And Processes Of Science** | | |
| 2. Conservation | 2-9 | 1, 3, 5, 6, 9, 10 |
| **VI. Science and Technology** | | |
| 1. Problem Identification | 5, 6 | |
| 2. Solution Design-Cost, Risk-Benefit Analysis | 7-9 | |
| 4. Solution Evaluation | 2, 7-9 | 9 |
| **VII. Science and Societal Challenges** | | |
| 1. Population Growth | 5, 6 | |
| 2. Natural Resources | 2-9 | 1-10 |
| 3. Environmental Degradation | 2-7 | 3, 9 |
| 4. Natural and Human-Induced Hazards | 2-5 | |
| 5. Community Health | 2-4 | 4, 6 |
| 6. Global Change | 6-8 | |
| **VIII. History/Nature of Science** | | |
| 1. Scientific Inquiry | | 2 |
| 2. Scientific Explanations | | 2 |

# Biodiversity

Tourists visiting the National Zoo in Washington, D.C., stare in fascination at the giant pandas contentedly munching bamboo branches. It's easy to become emotionally involved at the thought of this lovable species becoming extinct, and pandas have many advocates. But few people know or care about tiny insects on the floor of tropical forests as they become extinct. Every day, around the globe, species are lost; others are sentenced to extinction. The Earth's biological diversity is more threatened today than at any other time in the past 65 million years. This lesson examines the importance of biodiversity, looks at why it is threatened, and suggests ways of conserving it.

The lesson begins with a case study highlighting a Costa Rican program to catalog the country's biodiversity. The symptoms of biodiversity loss are identified, as well as underlying causes. After a consideration of why we should be concerned about biodiversity loss, the lesson concludes with strategies to conserve biodiversity.

## Objectives

By the time they finish this lesson, students should be able to:

- Define biodiversity and give examples of genetic, species, and ecosystem diversity.
- List ways in which biodiversity is threatened.
- Distinguish between symptoms and root causes of biodiversity loss.
- Communicate reasons why biodiversity is valuable and should be preserved.
- Identify strategies that can be used at the local, national, and international level to preserve biodiversity.
- Identify actions they can take to help preserve biodiversity.

## Teaching Strategies

This lesson is divided into seven parts. If you wish to follow the lesson plan, allow two class periods. Because the lesson is designed for flexibility, each part may be enhanced with additional materials or enrichment activities. You might wish to plan a field trip to a zoo, botanical garden, arboretum, or other site in your community.

An alternate approach would be to combine the overhead transparency masters and student handouts to create a packet of materials for use by individual students or small groups. Along with the packet, give students a list of questions to pursue. Once students have begun some research and/or discussion, discuss their answers and any additional questions they have with the whole class.

Appropriate questions include the following:

- *What is biodiversity?*
- *What is meant by "loss of biodiversity"? Where is this occurring?*
- *What are symptoms of biodiversity loss?*
- *What are the root causes of biodiversity loss?*
- *Why should we be concerned about loss of biodiversity?*
- *What are some strategies to preserve biodiversity?*
- *What can you do to preserve biodiversity?*

The lesson includes the following materials that may be duplicated:

## Student Handouts:

1 Test Yourself: How Much Do You Know About Biodiversity?
2 Facts About Biodiversity
3 Collecting Species Data in Costa Rica
4 Answers to "How Much Do You Know About Biodiversity?"

## Overhead Transparency Masters:

1 Species Remaining to be Described
2 Wetland Loss in Selected Industrialized Countries, 1950–80
3 Trends in Deforestation and Population Growth, 1850–1980
4 Tropical Areas with Rich Floral Diversity

This lesson was based on the *Global Biodiversity Strategy*, the *Global Biodiversity Strategy: A Policy Maker's Guide, Keeping Options Alive*, and *Issues and Ideas: The United States Needs a National Biodiversity Policy* (Available from the World Resources Institute. See "Suggestions for Further Reading, p. 10).

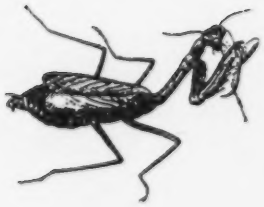
## Beginning the Lesson

Distribute copies of **Handout 1, "Test Yourself: How Much Do You Know About Biodiversity?"** Explain that this exercise is designed as a pretest, to measure what students know before studying the topic. Allow time for students to complete the exercise (about 10 minutes).

Tell students they can change their answers later if they want to. After completing this lesson, students can go back to their original answers to see what they have learned. **Handout 4, "Tropical Areas with Rich Floral Diversity,"** is an answer sheet.

### Examining a Case Study

Distribute copies of **Handout 2, "Facts About Biodiversity,"** and **Handout 3, "Collecting Species Data in Costa Rica."** Use a map to show the location of Costa Rica. Allow students time to read the case study. Use the following questions from **Handout 3** to discuss the case study:



*What is biological diversity or biodiversity?* The variety among living organisms and the ecological communities they inhabit. The INBIO case study discusses one type of biodiversity, species diversity—the variety of species within a region. There are two other types: genetic diversity—the variation of genes within a species, and ecosystem diversity—differences among groups of organisms in different physical settings.

*What is the purpose of this national biodiversity survey?* The purpose is to catalog on computer all species, giving information about name, location, conservation status, and potential commercial uses.

*How do "parataxonomists" differ from taxonomists?* Taxonomists are scientists who specialize in identifying and classifying species. "Parataxonomists" are local people—farmers, ranchers, high school students, etc.—who have received special training to assist the taxonomists by doing the collecting and preliminary identification. (The term "paraprofessional" means a trained aide who assists a professional person, such as a paramedic or paralegal.)

*Why is the INBIO survey using "parataxonomists"?* Because there are few taxonomists and many thousands of species to collect and identify.

*Why is Merck & Co. paying US$1 million to fund the biodiversity study?* Merck has successfully developed pharmaceuticals from natural sources and is looking for potential drugs in the plant, insect, and microbe samples from the INBIO study.

*If any medicines are developed, will this help efforts to conserve the Costa Rican forests?* Yes. Rather than harvesting the forests, Merck will synthesize the chemical compounds in the laboratory. Any money that Merck makes from selling the medicines will be shared with Costa Rica. This money—royalties—and part of Merck's initial funding will be used to conserve biological diversity in the Costa Rican National System of Conservation Areas.

*How likely is it that this project will yield new medicines?* No one can predict the success. However, approximately one-fourth of all prescriptions dispensed in the United States are derived from plants. Three quarters of the world's people depend on traditional medicines derived from plants. Some plants have yielded important drugs—the rosy periwinkle from Madagascar yields a substance used to treat childhood leukemia, for example. Pharmaceutical houses now have rapid, automated screening equipment that speeds up research on plants. Once a promising substance has been identified, chemists try to synthesize it in the laboratory, as is being done currently with the taxol molecule from the Pacific yew tree.

*If you and other students were to train as "parataxonomists" and conduct similar collecting trips in local habitats (forests, wetlands, etc.), would you be likely to find as many new species as the INBIO collectors?* No. The INBIO collectors are working in the tropical forests, which are richer in species than any other habitat. Closed tropical forests contain at least 50 percent and perhaps 90 percent of the world's species. However, an exercise of this type in a local forest or field environment might help students understand what the INBIO project is like. See **Activity 2, "Conduct a Census."**

## Describing Loss of Biodiversity

*What is loss of biodiversity?* Extinction of species or loss of unique habitats and ecosystems or reduction of genetic variations within a species.

*What are some examples of species that have become extinct?* Famous examples are the passenger pigeon and the dodo. [Note: Before beginning this lesson, you might want to have students research some of the extinct birds and animals and the causes for extinction. An excellent source is David Day's *Vanished Species* (Gallery Books, New York, 1989).]

Can students name animals or birds that are currently threatened with extinction: the California condor, the giant panda, the golden lion tamarin, and others. In the past, many species have become extinct. What is new today is the large numbers that are threatened and the rapid pace of extinction. Continued loss or degradation of habitats at the present rate could doom up to 15 percent of the Earth's species over the next 25 years.

*How can loss of biodiversity be measured?* It is extremely difficult to measure loss of biodiversity. Take one kind of biodiversity—species diversity. First of all, the total number of species is unknown. Show a transparency made from **Overhead Transparency Master 1, "Species Remaining to be Described."** The total of 10 million species is an estimate—biologists think there are between 5 million and 30 million species. Secondly, many species are tiny and inconspicuous: microbes, insects, and sea creatures. Thirdly, many species live in remote or inaccessible areas. Some species may be known by local people but have never been studied and named by scientists.

Another kind of biodiversity, the variation of genes within a species, is sometimes easier to measure, at least for species grown for food. There are some records of the loss of genetic diversity. For example, according to the U.S. Department of Agriculture, of more than 7,000 apple varieties in use between 1804 and 1904 in the United States, 86 percent have been lost; of 2,683 pear varieties, 88 percent are no longer available through seed banks. (See **Activity 1, "Investigate Apples."**)

One way to estimate biodiversity loss is to measure loss of specific habitats. Show a transparency made from **Overhead Master Transparency 2, "Wetland Loss in Selected Industrialized Countries, 1950–80."** The graph shows that the United States and several other European countries have lost substantial portions of their wetlands in just 30 years.

*As wetlands disappear, what kinds of species are likely to be lost?* Wetlands, particularly along the coasts, are habitat for waterfowl and valuable breeding and nursery grounds for fish and shellfish. Ninety percent of the world's marine fish catch reproduces in these areas.

Other habitats are threatened: islands with unique species, such as Madagascar and Hawaii; freshwater lakes; mangroves; and coral reefs. Coral reefs are habitats as biotically rich as tropical forests, but they are under severe pressure from pollution, soil erosion, and possibly global climate change.

The loss of forest habitat has probably received the most publicity. Show a transparency made from **Overhead Transparency Master 3, "Trends in Deforestation and Population Growth, 1850–1980,"** to illustrate loss of forests. Point out the decline of temperate forests in Northern countries, and tropical forests of Southeast Asia, tropical Latin

America, and central and west-central Africa. Explain that it is difficult to measure deforestation (or other forms of habitat loss) precisely. Recent studies of global deforestation are based in part on satellite images, but there are difficulties in collecting data, and all figures are estimates.

To estimate how many species are affected by loss of habitats, scientists take into account the relationship between the size of an area and the number of known species it holds. For example, a recent analysis of tropical forest habitat (which contains 50–90 percent of the world's species) concluded that at current rates of deforestation, 4 to 8 percent of rainforest species would be sentenced to extinction by 2015 and 17 to 35 percent by 2040. "Sentenced to extinction" means that the species is likely to lose the ability to breed and reproduce in the future. It lacks the habitat, food sources, or breeding conditions that are necessary for a viable population of the species.

*Besides habitat loss, what else threatens biodiversity?* Other threats include:

- *Alteration and fragmentation of habitat.* For example, in North America, the breakup of contiguous forests has seriously harmed many populations of songbirds.
- *Overexploitation of plant and animal species.* Many species are overexploited for our food and shelter, but the search for precious commodities, such as ivory, and for pets, curiosities, and collector's items has threatened other species as well.
- *Pollution of soil, water, and atmosphere.*
- *Introduction of nonnative species.* New species can crowd out native species. For example, on the island of Guam, the brown tree snake has caused the extinction of three of the island's five endemic bird species and has nearly eliminated the other two.
- *Industrial agriculture and forestry.* Modern plant breeding programs have led to fewer varieties of crops. In the Green Revolution, farmers abandoned traditional varieties of crops in favor of higher-yielding new varieties. A tree plantation that consists of one species of tree is very different from a diverse forest ecosystem.
- *Global climate change.* If global warming occurs, species that cannot adjust to warmer temperatures are likely to become extinct.

## Identifying the Root Causes of Biodiversity Loss

Habitat loss is a symptom or an immediate cause of biodiversity loss. But any strategy to preserve biodiversity must take into account the underlying or root causes.

For a second time, show a transparency made from **Overhead Transparency Master 3, "Trends in Deforestation and Population Growth, 1850–1980."** This time, focus on the population increase since 1900 and the connection between this increase and deforestation. The graph clearly shows two root causes of biodiversity loss: (1) population growth and (2) increasing consumption of resources.

*Why have the world's forests decreased as the population increased?* Forests have been cut down so that the land can be used for

agriculture. There are more and more people to be fed. There is an increasing demand for timber, for everything from chopsticks and paper to housing and furniture. Wood is the major source of energy in the developing countries, whose populations are increasing most rapidly.

*Are these trends likely to continue?* Yes. The world population will probably double over the next 50 years. This will greatly increase the pressure on forests and other renewable resources.

*How do population growth and increasing resource consumption affect biodiversity?*

- These trends pressure humans to convert wildlife habitat into agricultural and urban land. Remind students of changes they have seen in their community, as woods and fields are converted to housing developments, roads, shopping centers, schools, etc. (If you have any pictures of land use changes in your community, such as farms being converted to housing developments, show these.)
- These trends produce wastes that pollute habitat and poison wildlife.

*What else causes biodiversity loss?* Other causes include:

- *Ignorance about species and ecosystems.* A species may be lost because we didn't know it existed at a site that was developed. In some cases, a species may be known locally but the knowledge may die out as traditional ways of life change.
- *Government policies.* For example, policies that encourage agriculture or forestry can destroy biodiversity.
- *Effects of global trading systems.* The trend is toward specialization. Developing countries concentrate on certain crops such as coffee or bananas. As the number of crop species declines, so does the complex system of supporting species such as insects that pollinate the crops. Creation of large plantations also destroys species-rich forests and wetlands.
- *Inequity of resource distribution.* Local communities who depend on land and biotic resources (for example, indigenous peoples of the rainforest) don't control the resources. Richer countries have technology and money to develop and exploit the natural resources of poor countries. Also, most poor countries are heavily in debt.
- *Value of biodiversity is ignored.* Biodiversity is immensely valuable, but this value isn't recognized. For example, the value of nontimber goods that the forest provides—fruits, nuts, resins, oils, subsistence food, and fuelwood—are ignored in economic assessments of forest use, but studies show their value may far exceed that of the timber.

*Are these root causes of biodiversity loss interconnected?* Yes, they tend to interact. For example, in Asia, the global market for shrimp has encouraged national governments to create policies favoring investment in shrimp farming. To do this, coastal mangrove swamps, an important habitat for fish, have been destroyed. Shrimp farming uses up freshwater resources and pollutes the water, which is flushed into man-

groves. Costs of the habitat loss are paid by local people who depend on the mangrove ecosystems for fish protein, revenue, and forest materials.

### Identifying Reasons for Concern About Biodiversity Loss

*Why should we be concerned about loss of biodiversity?* Answers to this question can be developed along several different lines:

- *Aesthetic.* Each species and ecosystem adds to the richness and beauty of life on Earth. Once a species becomes extinct, it is gone forever. When an ecosystem is destroyed, it is either impossible or extremely difficult to recreate it.
- *Ethical.* Each species is unique and has a right to exist. Each species is worthy of respect regardless of its worth to human beings. This point of view was recognized in the World Charter for Nature, adopted by the United Nations in 1982.
- *Economic.* Each species is of potential value to humans, as are healthy ecosystems. The global collection of genes, species, habitats, and ecosystems is a treasure trove that provides for human needs now and is essential for human survival in the future. Humans depend on other species for all of their food and many medicines and industrial products. Humans also depend on the intricate functioning of other species to provide "ecological services," such as purifying water, cycling nutrients, and breaking down pollutants. Genetic diversity is important in breeding crops and livestock. The loss of crop species has severe implications for global food security. Crop breeders need a diversity of crop varieties in order to breed new varieties that resist evolving pests and diseases. Many crops have been "rescued" with genetic material from wild relatives or traditional varieties. Biodiversity represents a "living library of options for adapting to local and global change."
- *Ecological.* Species evolve to fill particular niches or habitats. Many species depend on each other in intricate ways for survival. Destroying one species can lead to further extinctions or changes. No one can be sure where we begin the road to no return. With each extinction, life on the planet gets closer to extinction.

### Examining Strategies for Conserving Biodiversity

Issues of biodiversity are complex. To develop strategies, choices must be made. Where to begin? What is most important to save? These choices can be made from three different perspectives:

- *Global.* Biodiversity should be preserved as the common heritage of all humans. All species have a right to exist. This is most often the perspective of northern countries looking at biodiversity loss in tropical countries. This perspective sets as a priority conserving "hot spots" around the globe where biodiversity is richest or most threatened. The goal is to conserve as much biodiversity as possible, given limited financial resources.

Use a transparency made from **Overhead Transparency Master 4, "Tropical Areas with Rich Floral Diversity,"** to show areas that are species-rich. Fourteen of the 18 hot spots are in the topics. Almost 14 percent of the world's plants are found only in these areas.

- *National.* Priority is given to conserving as many native species as possible. In countries with low biotic diversity, the loss of even a few species would be significant. From this perspective, it is most important to establish good conservation practices in each country rather than focusing on a few scattered international habitats.
- *Local.* Local people often depend on plants and animals, yet they must struggle with national or international forces for control. Often, local cultures have no say in what happens to local resources, nor do they profit from exploitation of resources. Yet, they are the ones who suffer most from loss of biodiversity.

There are three basic elements of conserving biodiversity.

1. Save it.
2. Study it
3. Use it sustainably and equitably.

Write these three approaches on the chalkboard. Then, ask students to take another look at the case study in **Handout 3, "Collecting Species Data in Costa Rica."** Can students identify these three approaches?

- The program focuses on identifying and studying the country's biological diversity.
- The government has set up a national system of conservation areas to preserve biodiversity. Part of Merck's US$1 million initial payment and future royalties will go to fund the conservation areas.
- The Costa Rican people will benefit from any profitable results of this study. In the past, pharmaceutical and agricultural interests have had unrestricted access to tropical plants and animals without providing what many developing countries consider adequate compensation. For example, the successful drug developed from the rosy periwinkle of Madagascar has generated US$100 million in revenue annually, but none of this has gone to the country of origin.

The INBIO program shows that loss of biodiversity is not a hopeless, inevitable situation. There are many things that can be done—by individuals, by local and national governments, by nations working together, and by citizen action.

Examples of strategies include:

### *International Level*

- The *Global Biodiversity Strategy* was initiated by the World Resources Institute, the World Conservation Union, and the United Nations Environment Programme during an intensive process of research, technical workshops, world-wide peer review and regional dialogues. The *Strategy* is a conservation blueprint that incorporates the broader social and economic concerns of biodiversity loss (Available from the World Resources Institute, Washington, D.C.).
- The Convention on Biological Diversity was introduced at the Rio Earth Summit in June 1992 and enacted in December 1993 after it

was ratified by the required 30 countries. Nations joining the Convention agree to develop national strategies to protect biodiversity, while maintaining rights over their biological resources. (Available from United Nations Commission on Sustainable Development, Room S-3060A, United Nations Plaza, New York, N.Y. 10017.)

### *National Level*

Governments can address root causes of biodiversity loss by:

- Reforming existing policies that invite the loss of biodiversity, such as agricultural policies that subsidize use of pesticides, fertilizers, and water, or policies that encourage wasteful, unsustainable logging.
- Adopting new policies and accounting methods that promote conservation. Under current accounting systems, ecological disasters can appear profitable. For example, the oil spill from the *Exxon Valdez* actually increased the U.S. gross national product. Billions of U.S. dollars were spent on cleanup, but the resource losses did not show up.
- Reducing demand for biological resources. This can be done by trying to reduce population growth through universal access to family planning. Recycling and conservation measures also reduce demand.
- Integrating biodiversity conservation into national planning. When countries set biodiversity priorities, assess their natural resources, and determine what they have to offer and what they want in return, they have an advantage at the international bargaining table. Costa Rica is an example.

## Concluding the Lesson

Ask students to suggest ways in which they can act to preserve biodiversity. Include references to student enrichment activities later in this chapter, as appropriate.

*What can students do to study biodiversity?* Take courses in school; subscribe to magazines; attend education programs at local museums, zoos, nature centers, etc.; watch television programs.

*What can students do to save biodiversity?* They could join a local citizen action group or form a new one in the school community; join and support local, national, and international conservation organizations (see **Activity 9, "Adopt an Endangered Animal,"** and **Activity 10, "Write Letters"**); work as a volunteer in a park or zoo; support laws that protect habitat (for example, zoning laws). Saving seed species is a way to help protect the gene pool. (See **Activity 5, "Learn About Antique Seeds,"** and **Activity 8, "Try Gardening."**)

*What can they do to use biodiversity sustainably and equitably?* What changes could they make in their buying habits and lifestyle to reduce consumption of resources? What options exist for recycling?

Finally, have students return to **Handout 1, "Test Yourself: How Much Do You Know About Biodiversity?"** Using **Handout 4, "Answers to 'How Much Do You Know About Biodiversity'**," discuss answers with students. Which fact was most surprising? Ask students to tell how their initial ideas about biodiversity have changed over the course of the lesson.

Mark S. Fisher

## Suggestions for Further Reading


- Cary Fowler and Pat Moon, *Shattering: Food, Politics, and the Loss of Genetic Diversity* (University of Arizona Press, Tucson, Arizona, 1990).
- Boyd Gibbons, "Missouri's Garden of Consequence," *National Geographic* (August 1990), pp. 124–140.
- Constance J. Poten, "America's Illegal Wildlife Trade: A Shameful Harvest," *National Geographic* (September 1991), pp. 106–132.
- Walter V. Reid and Kenton R. Miller, *Keeping Options Alive: The Scientific Basis for the Conservation of Biodiversity* (World Resources Institute, Washington, D.C., 1989).
- Walter V. Reid, *The United States Needs a Biodiversity Strategy, Issues and Ideas* (World Resources Institute, Washington, D.C., 1993) FREE.
- David Rains Wallace, *Life in the Balance* (Harcourt Brace Jovanovich, San Diego, 1987).
- Fred Ward, "Florida's Coral Reefs Are Imperiled," *National Geographic* (July 1990), pp. 115–132.
- Edward O. Wilson, *The Diversity of Life* (The Belknap Press of Harvard University Press, Cambridge, Massachusetts, 1992).
- World Conservation Monitoring Centre, *1990 IUCN Red List of Threatened Animals* (Island Press, Washington, D.C., 1990).
- World Resources Institute, *Global Biodiversity Strategy: Guidelines for Action to Save, Study, and Use Earth's Biotic Wealth Sustainably and Equitably* (World Resources Institute, Washington, D.C., 1992).
- World Resources Institute, *Global Biodiversity Strategy: A Policy Makers Guide* (World Resources Institute, Washington, D.C., 1992) FREE.

## 1 Investigate Apples

Ask students to see how many varieties of apples they can name. Tell them, as mentioned in the lesson plan, that at the beginning of this century, there were more than 7,000 apple varieties in use in the United States; today, 85 percent of these have been lost. Have students bring to class as many different kinds of apples as they can find. Discuss how the different kinds vary in size, color, shape, and taste. Ask students to consider why a few varieties, such as Red Delicious and Golden Delicious, have become so popular. Why do we need many varieties? Is it important to preserve rare varieties? For example, Seed Savers Exchange in Decorah, Iowa is developing an orchard to preserve 500 old-time apple varieties. Explore how new varieties of apples are developed.

**Skills emphasis:*** *Science III 1, III 3, V 2, VII 1*

**Suggested for use in:** *Environmental Issues, Social Studies, Biology, Home Economics.*

## 2 Conduct a Census

Tropical rain forests are characterized by an amazing number of different plant species. A tract less than 2 ½ acres (1 hectare) of Peru's Amazon forest contained 275 species of trees. In a study of 120 square yards (100 square meters) of lowland tropical rain forest in Costa Rica, 223 species of vascular plants were counted. A tract of woodland in a temperate area in the United States or Canada has many fewer species. To illustrate this contrast, take a census of a tract of woodland near you, either on private land if you have access to it or in a public park. Develop a plan to record the different species of trees, using guidebooks and other materials to help identify them. If possible, record bushes, flowering plants, grasses, and other species. Write a report, summarizing findings and making generalizations about numbers and types of plant species found.

**Skills emphasis:** *Math I 2, II 3, X 4; Science I 2, II 1, II 4, VII 2, VIII 1–2*

**Suggested for use in:** *Biology, Ecology, Plant Science.*

## 3 Study the State of Your State or Province

There's a lot of talk about endangered species in other parts of the country and other regions of the globe. But what is the status of native plant, bird, and animal species in your state? Which have become extinct? Which are endangered? For example, according to the Maryland Department of Natural Resources (*The Baltimore Sun*, January 27, 1992, p. B1), that state has lost 203 plant and wildlife species; another 413 are endangered or threatened. Which areas of your state are richest in species? For example, are there old-growth forests? What are the greatest threats to habitat? How much habitat has been changed or lost by development? How do state government policies affect wildlife? For example, the "chickadee checkoff" allows Marylanders to check a box on their state income tax return to give money to protect endangered species. What is being done by businesses and nongovernmental organizations to preserve wildlife habitat? What local education programs (at parks, nature centers, museums, etc.) are available to help students learn about local wildlife? What volunteer conservation activities are available to students on weekends and vacations? Students might publicize the results of their research in school publications and community newspapers.

**Skills emphasis:** *Geo I 3; Science III 1, III 4, V 2, VII 2–3*

**Suggested for use in:** *Social Studies, Environmental Issues, Geography, Ecology.*

## 4 "Seeds of Change" Traveling Exhibit

"Seeds of Change," a traveling exhibition organized by the American Library Association and the Smithsonian Institution Traveling Exhibition Service, is a wonderful, historical lesson in the effects of biodiversity based on Christopher Columbus' voyages to the New World. The exhibit presents five "seeds of change," *corn, potatoes, sugar, disease, and horses,* that dramatically changed both the Old and New World. Students can see how the introduction of new plant and animal species did not just change the diet of a culture, but changed economic and lifestyle patterns, affected health, and even led to the transportation of African peoples to the new world to serve as slaves. The "Seeds of Change" traveling exhibit is scheduled to visit more than 50 U.S. cities in 1992-93; for information, contact the American Library Association, 50 East Huron Street, Chicago, Illinois 60611. To order the companion book *Seeds of Change* (Herman J. Viola and Carolyn Margolis, eds.), contact AIDC, P.O. Box 500, Williston, UT 05495. Phone: (800) 927-7377.

**Skills emphasis:** *Geo IV 9–12, V 16, VI 17; Hist III 4, IV 4–5; Science III 1, III 4, VII 2, VII 5*

**Suggested for use in:** *Social Studies, Geography, History, Plant Science.*

*See chart of Draft National Performance Standards at beginning of this unit.*

## 5 Learn About Antique Seeds

Heirloom or antique varieties of fruits, vegetables, and flowers are the ones our great-grandparents used. Seeds of some of these varieties are still available because people have followed the example of George Washington, who was an avid seed collector. He often asked friends to bring him seeds as gifts. At Mount Vernon, his home in Virginia, he began a seed collection program on the plantation as soon as the gardens began producing. Present-day conservators of Mount Vernon's gardens still collect flower seeds from the same plant varieties and package them for sale. (Write to The Museum Shop, Mail Order Department, Mount Vernon, Virginia 22121, or call (703) 780-2000, ext. 283.)

Several thousand backyard gardeners are members of Seed Savers Exchange (SSE) in Decorah, Iowa. Members save heirloom varieties, traditional Indian crops, and varieties from Mennonite and Amish gardens and then send seeds to people who want to raise them. For more information, send a self-addressed stamped envelope to Seed Savers Exchange, 3076 North Winn Rd., Decorah, Iowa 52101. Other sources of information include:

Gardener's Supply Co.
128 Intervale Road
Dept. NNE
Burlington, VT 05401
(802) 863-1700

Native Seeds/SEARCH
2509 N. Campbell Ave.
No. 325
Tucson, AZ 85719
(602) 327-9123

Southern Exposure Seed Exchange
P.O. Box 170
Earlysville, VA 22936

Seeds of Change
621 Old Santa Fe Trail
No. 10
Santa Fe, NM 87501

**Skills emphasis:** *Science III 1, III 3, V 2, VII 2*

**Suggested for use in:** *Biology, Social Studies, Environmental Issues.*

## 6 Study Medicines That Come from Plants

The plant species of the tropical forests hold a vast and unknown potential for relieving human suffering. Although only a few plants have been thoroughly studied, over 25 percent of modern medicines are derived from natural sources, mainly plants. Have students choose one of the following drugs and do research on it: atropine, curare, digitoxin, diosgenin, morphine, quinine, reserpine, and vincristine. What is the source of the drug? What is it used to treat? How were its medicinal properties discovered? Findings should be presented in a brief oral or written report.

**Skills emphasis:** *Science I 2, III 6, V 2, VII 2, VII 5*

**Suggested for use in:** *Biology, Plant Science.*

## 7 Investigate New Foods

Only three plants—wheat, rice, and maize—provide over half the food humans eat, but thousands of plants are known to be edible. Chances are, unfamiliar fruits and vegetables have been appearing in the produce sections of supermarkets in your area: carambola ("Star Fruit"), jicama, Asian pears, exotic mushrooms. There are many more. Have each student select one of these unusual foods and find out where it originated, where it is grown (is it grown locally or imported), and how to prepare it. Supermarkets sometimes can provide information about how to choose and prepare unusual fruits and vegetables. Have students bring foods to class and hold a tasting session.

Have students also select a plant species that is not yet available but may be a source of food in the near future. Amaranth, for example, was once the Aztec's most important crop. It may become a major food source because it thrives in a hot, dry climate. Other plants include the winged bean (*Psophocarpus tetragonolobus*) of New Guinea, which has been called the one-species supermarket, the wax gourd (*Benincasa hispida*) of tropical Asia, and the Babussa palm (*Orbigyna martiana*), an Amazonian tree known as the "vegetable cow." Create a display with pictures or samples of each plant including information about its cultivation and current or potential uses.

**Skills emphasis:** *Geo I 1, V 16; Science III 1, III 4, VII 2*

**Suggested for use in:** *Environmental Issues, Social Studies, Home Economics, Ecology, Biology, Plant Science.*

## 8 Try Gardening

Obtain some unusual seeds for vegetables, flowers, or herbs, either from a local farmer or gardener or from one of the sources listed in **Activity 5, "Learn About Antique Seeds."** Create a garden, either at home or at school. Save seeds in a school seed bank or library.

Or, create a butterfly garden containing colorful flowers that attract butterflies. A book by the Xerces Society and the Smithsonian Institution, *Butterfly Gardening* (Sierra Club Books, San Francisco, 1990) ($19.00) and other information are available from the Xerces Society, 10 Southwest Ash Street, Portland, Oregon 97204. Phone: (503) 222-2788.

**Skills emphasis:** *Science III 1, III 6, VII 2*

**Suggested for use in:** *Ecology, Environmental Issues, Plant Science, Biology.*

## 9 Adopt an Endangered Animal

Have each student choose an endangered animal species. The student should gather information about the animal (habitat, numbers in existence, threats to its survival, etc.) and about attempts to preserve it. What is being done to preserve the species and by whom? What are the animal's chances of survival? [Contact the World Wildlife Fund, 1250 24th Street, NW, Washington, DC 20037. Lydia Anderson, phone: (202) 293-4800 for fact sheets on endangered species.] Some zoos have programs by which people can "adopt" an animal and give financial support. In other cases, support is possible through an international conservation organization. Students might plan and implement a fund-raising campaign to raise money for a specific animal species or for an organization.

**Skills emphasis:** *Science III 1, V 2, VI 4, VII 2, VII 5*

**Suggested for use in**: *Social Studies, Environmental Issues, Biology.*

## 10 Write Letters

Writing letters is a good way to find out about organizations that are working to preserve biodiversity. Sources of information include the following:

- Conservation International, 1015 18th Street, NW, Suite 1000, Washington, DC 20036
- Cultural Survival, 11 Divinity Avenue, Cambridge, MA 02138
- Earthwatch, P.O. Box 403N, Mt. Auburn Street, Watertown, MA 02272
- Greenpeace Activist Network, 1436 U Street, NW, Washington, DC 20009
- Missouri Botanical Garden, Box 299, St. Louis, MO 63166
- National Audubon Society, 666 Pennsylvania Ave., SE, Suite 200, Washington, DC 20003-4319
- National Wildlife Federation, 1400 16th St., NW, Washington, DC 20036-2266
- Nature Conservancy International, 1815 North Lynn Street, Arlington, VA 22209
- Rainforest Action Network, 450 Sansome, Suite 700, San Francisco, CA 94111
- World Wildlife Fund/Conservation Foundation, 1250 24th Street, NW, Washington, DC 20037
- World Wildlife Fund, 90 Eglinton Ave., East, Suite 504, Toronto, Ontario MHP 2Z7 CANADA

Once information about these organizations has been obtained, students could choose one or more to join. Some organizations encourage specific kinds of actions such as letter-writing campaigns.

**Skills emphasis:** *Science III 1, V 2, VII 2*

**Suggested for use in:** *English, Environmental Issues, Social Studies.*

### Audiovisual Resources

- *Banking on Disaster,* Adrian Cowell, (1988), VHS, 78 min. (3 segments, 26 min. each), Bullfrog Films.
- *Biodiversity: The Variety of Life,* (1992), VHS, 42.5 min., Dal Neitzel, Bullfrog Films. *Focuses on the Greater Northern Cascades ecosystem of Washington state and British Columbia, with a clear explanation of conservation biology.*
- *Equatorial River: The Amazon,* National Film Board of Canada, VHS and 16 mm, 23 min., Bullfrog Films.
- *The Great Gene Robbery,* Turning the Tide Series, VHS, 26 min., Tyne Tees Television, Bullfrog Films. *We rob the world of its genetic diversity at our own peril.*
- *Jungle Pharmacy,* VHS, 60 min., TBS, Inc., Library Tape Sales.
- *Our Threatened Heritage,* 20 min., National Wildlife Federation.
- *Rivers to the Sea,* National Film Board of Canada, VHS and 16mm, 46 min., Bullfrog Films.
- *Sea of Slaughter,* VHS, 96 min. (available in four parts) Canadian Broadcasting Corp., Bullfrog Films. *Author Farley Mowat chronicles five centuries of exploitation of marine mammals and fish in the North Atlantic and Pacific.*
- *Seeds,* Kensington Communications, VHS and 16 mm, 28 min, Bullfrog Films. *A concise explanation of the importance of genetic diversity to the world food supply.*
- The Temperate Rain Forest, VHS, 16 min., National Film Board of Canada, Bullfrog Films. *Character and ecology of coastal forest of the Pacific Northwest.*

22

# Test Yourself: How Much Do You Know About Biodiversity?

Mark **T** in front of each statement you believe is true, and mark **F** in front of each statement you believe is false.

____ 1. The total number of species is not known.

____ 2. More than one half of the world's species live in tropical forests.

____ 3. About 10 million species have been identified by scientists.

____ 4. The Earth has many more species than it needs.

____ 5. Most species are of no direct benefit to humans.

____ 6. Some habitats have more species than others.

____ 7. Biodiversity includes genetic diversity, species diversity, and ecosystem diversity.

____ 8. Biological diversity is more threatened now than at any time in the past 65 million years.

____ 9. The loss of forests, wetlands, grasslands, and other habitats contributes to loss of biodiversity.

____10. Many species become extinct without ever being identified.

____11. Large plants, birds, and mammals make up about half the world's species.

____12. The countries with the most species of vascular plants are located in Central and South America and in Southeast Asia.

____13. Coral reefs are as rich in biodiversity as tropical forests.

____14. Many islands are home to species found nowhere else.

____15. Fewer than 100 species currently provide most of the world's food supply.

____16. Crop breeders need a diversity of crop varieties in order to breed new varieties that resist insect pests and diseases.

____17. Creating parks and zoos is the best way to preserve biodiversity.

____18. The biological resources of developing countries are a potential source of income.

____19. Two major causes of biodiversity loss are population growth and the increasing consumption of natural resources.

____20. Once a species becomes endangered, it is doomed to extinction.

23

# Facts About Biodiversity

Tropical forests are a unique and endangered resource. They provide habitat for millions of plant and animal species, recycle nutrients, protect soils and watersheds, and provide many products and services to people. These forests are being cleared rapidly, causing habitat destruction and extinction of species. Deforestation threatens biodiversity, a global resource made up of the variety and variability of life forms on Earth, both wild and domesticated. Biodiversity includes (1) genetic diversity, (2) species diversity, and (3) ecosystem diversity.

## State of the Forests

- About one third of the world's land area is covered by forests.
- Just over one half of the world's forests are in developing countries.
- New studies by the United Nations Food and Agriculture Organization indicate the world is losing about 15.4 million hectares (an area four times the size of Switzerland) of tropical forests each year.
- Causes of deforestation include permanent conversion to agricultural land; logging; demand for fuelwood, fodder, and other forest products; grazing; fire; and drought.
- The rate of deforestation is highest in Asia (1.2 percent per year from 1981–90), followed by Latin America (0.8 percent), and Africa (0.7 percent). In the same period, more land was deforested annually in Latin America and the Carribean (7.4 million hectares) than in Africa (4.1 million hectares) and the Pacific or Asia (3.9 million hectares).
- Brazil has 30 percent of the world's tropical forests and the largest area of annual deforestation. The vast majority of trees cleared in the Amazon region are burned or left to rot when land is cleared for agriculture.
- Deforestation is second only to burning of fossil fuels as a human source of carbon dioxide, one of the major greenhouse gases that may cause the global climate to warm.
- Deforestation leads to soil degradation and destroys habitat, leading to the extinction of plants, animals, birds, and insects.

## State of the World's Habitat and Species

- The habitats richest in biodiversity are the tropical moist forests of Southeastern Asia, central and west-central Africa, and tropical Latin America. These forests, described as the global "hotspots," contain more than half of all species.
- At least half of the world's species are contained in just 7 percent of the world's land surface.
- The exact number of species on Earth is not known. Less than 5 percent of species in the tropics have been identified. Worldwide, on average, about three new species of birds are found each year. An estimated 40 percent of freshwater fishes in South America have not yet been classified.
- More than 700 species of vertebrates, invertebrates, and vascular plants have become extinct since 1600, and untold numbers probably became extinct without ever being described.
- Only 5 percent of the world's land surface is in national protected areas. These include nature reserves, national parks and monuments, habitat and wildlife management areas, and protected landscapes.

## Trends

- The rate of deforestation is more likely to increase than to stabilize, although in some areas, there has been dramatic improvement.
- There is growing concern about destruction of the forests, especially the tropical rainforests.
- Wildlife habitat is threatened by human encroachment and by the potential threat of climate change.

# Facts About Biodiversity *(continued)*

- The trade in animals and animal products is having devastating effects on some wildlife populations, such as elephants, parrots, and large reptiles.
- Global warming would lead to widespread extinctions because habitats would shift, shrink, or disappear.

## Talking about Biodiversity

This box contains definitions of some useful terms.

For further study, consult *Global Biodiversity Strategy* and *Global Biodiversity Strategy: A Policy Maker's Guide* (1992), published by the World Resources Institute, The World Conservation Union, and the United Nations Environment Programme, in consultation with the Food and Agriculture Organization and the United Nations Education, Scientific and Cultural Organization. This book outlines an action plan to change policies, reduce excessive consumption, live within the Earth's carrying capacity, and, thereby, conserve the diversity of life on Earth.

**biodiversity**—short for biological diversity—the totality of genes, species, and ecosystems in a region or the world.

**bioregion**—a land and water territory whose limits are defined not by political boundaries, but by the geographical limits of human communities and ecosystems.

**bioregional management**—incorporating biodiversity conservation policies into the management and development of a bioregion.

**biosphere reserves**—areas designated by the Man and Biosphere Programme of the United Nations Education, Scientific and Cultural Organization. These areas contain a core zone (dedicated to preserving biodiversity with no human interference) and a buffer zone.

**buffer zone**—the region near the border of a protected area in which some settlement and resource use is allowed.

**deforestation**—the process of clearing forests and converting the land to other uses such as agriculture.

**ecosystem diversity**—differences among groups of organisms in different physical settings.

**endemic species**—a species that is native to a particular region.

**ex situ conservation**—preserving wildlife away from the natural habitat, in a zoo, botanical garden, aquarium, or other facility.

**genetic diversity**—the variation of genes within a species.

**in situ conservation**—preserving wild plants and animals in their natural habitat.

**nonnative species**—a species that has been brought into a region from another place and does not naturally occur there.

**species diversity**—the variety of species within a region.

# Collecting Species Data in Costa Rica

*Costa Rica is a small country in Central America, located between Nicaragua and Panama. Once, almost all the country was covered by forests. Now, most of the forests have been cleared for agriculture, but the Costa Rican government has set aside 25 percent of its land as forest preserve. These forests are rich in biological resources, and a Costa Rican research institute is experimenting with a new way to investigate these valuable resources: training local people to gather and classify specimens from the tropical forest.*

## A New Model for a National Biodiversity Survey

The Instituto Nacional de Biodiversidat (INBIO), founded in 1989 with the help of the national government, is a private nonprofit organization based in Heredia. It serves as a clearinghouse for information on and monitoring of Costa Rica's flora and fauna—between 500,000 and 1 million species in all—and has begun a comprehensive national survey of them. The name, location, conservation status, and potential commercial uses of each species are catalogued on computer. Using the catalogue, researchers can look for possible chemical uses among newly described wild plant species. Plants free of insect damage or fungal growth, for example, may contain natural chemicals that act as insect repellents, growth inhibitors, or antibiotics. Such finds are worth money to agrochemical, pharmaceutical, or biotechnology companies. For a fee, INBIO helps commercial users "prospect" in the catalogue. INBIO's first major customer was Merck & Co., Inc., the world's largest pharmaceutical company, which has a successful history of developing pharmaceuticals from natural sources. In exchange for plant, insect, and microbe samples from INBIO, Merck agreed to pay INBIO US$1 million as well as royalties on the sale of any products that Merck ultimately develops. Both Merck and INBIO hope that useful chemicals found in samples could then be synthesized in the laboratory rather than harvested from the forest. Part of the research funding will go to the Costa Rican National System of Conservation Areas to conserve biological diversity in the field.

Costa Rica (like many tropical countries) has a shortage of taxonomists—scientists who can identify and classify species. INBIO's solution is innovative: it hires and trains local people to act as field collectors and do initial identification of insect specimens for the national biodiversity survey. The first class of 16 "parataxonomists" went into the field in 1989 and are now collecting 100,000 insect specimens per month. During their first six months, they collected four times as many insect specimens as had been put into Costa Rica's national collections during the previous 100 years. The parataxonomists include former housewives, farmers, ranchers, high school students, and national park guards. The specimens are sent from the field to INBIO, where apprentice curators classify them. Finally, international experts are brought in to confirm identifications and make definitive taxonomic judgments. (Reprinted from *World Resources 1992-93*, Oxford University Press, New York, 1992, pp. 137–138).

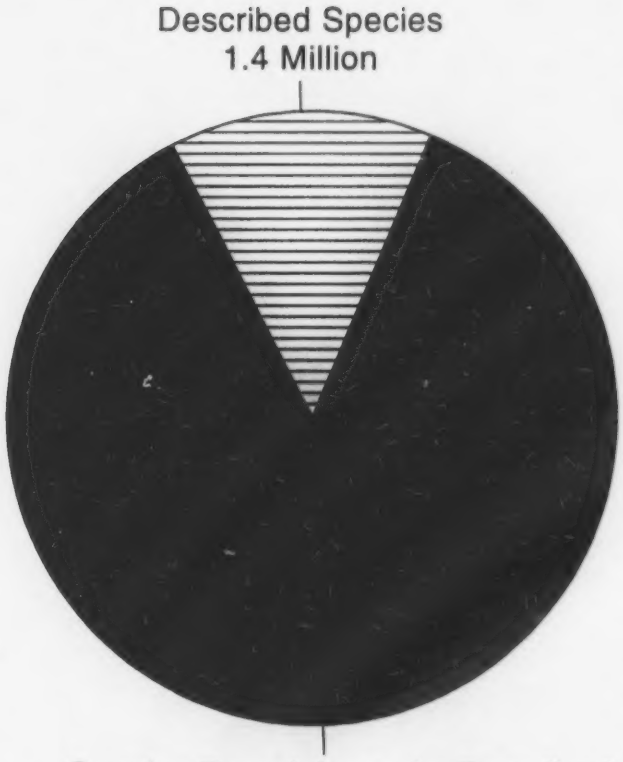
## Questions

1. What is biological diversity or "biodiversity"?
2. What is the purpose of this national biodiversity survey?
3. How do "parataxonomists" differ from taxonomists?
4. Why is the INBIO survey using "parataxonomists"?
5. Why is Merck & Co. paying US$1 million to fund the biodiversity study?
6. If any medicines are developed, will this help efforts to conserve the Costa Rican forests?
7. How likely is it that this project will yield new medicines?
8. If you and other students were to train as "parataxonomists" and conduct similar collecting trips in local habitats (forests, wetlands, etc.), would you be likely to find as many new species as the INBIO collectors?

# Answers to "How Much Do You Know About Biodiversity?"

1. *True.* There may be as many as 30 million species, but scientists estimate there are about 10 million. Most of them are inconspicuous organisms, such as microbes, insects, and tiny sea creatures.
2. *True.* Over one half of the world's species live in tropical moist forests.
3. *False.* It is estimated that fewer than 1.4 million of the world's species have been named. Most of the unidentified species live in the tropics. As we begin to explore other habitats, surprising discoveries are made. Scientists believe the deep sea floor could contain as many as a million undescribed species.
4. *False.* Species evolve to fill particular niches or habitats that exist on Earth. Many species depend on each other in intricate ways for survival. Destroying one species can lead to further extinctions or changes.
5. *True* or *False.* We don't know. Scientists are often delighted to find a cure for a dreaded human disease in a lowly mold or obscure plant. It seems foolish to destroy our genetic storehouse before we have even taken inventory. Also, extinction of a species can upset the balance of a complex ecosystem.
6. *True.* Some habitats, such as tropical forests, have many more species than others.
7. *True.* Biodiversity is a global resource made up of the variety and variability of life forms on Earth, both wild and domesticated.
8. *True.* Tropical deforestation is the main force behind this crisis. The destruction of wetlands, coral reefs, and temperate forests is also important.
9. *True.* As habitats are fragmented and destroyed, many species become extinct.
10. *True.* Habitats are destroyed without being studied. Ignorance about species and ecosystems contributes to species extinction.
11. *False.* Large, visible species of mammals, birds, and plants make up fewer than 5 percent of the world's species.
12. *True.* The world's rainforests are located in these countries.
13. *True.* Coral reefs are habitats of unparalleled biotic richness.
14. *True.* Remote islands such as Hawaii have unique flora because evolution takes place there in isolation.
15. *True.* Fewer species are grown today than in the past. Genetic diversity is declining.
16. *True.* Many crops have been "rescued" with genetic material from wild relatives or traditional varieties.
17. *False.* Zoos and parks are traditional strategies for protecting biodiversity and have helped preserve many species. However, newer strategies are needed to address the root causes of biodiversity loss.
18. *True.* As the INBIO study indicates, the vast genetic resources of tropical countries could become the "oil" of the 21st Century.
19. *True.* Other root causes are ignorance of species and ecosystems, poorly conceived policies (for example, those that favor deforestation), inequity in resource distribution, and the failure of economic systems to account for the value of biological resources.
20. *False.* Species can be protected by preserving habitat and by breeding and propagating programs in zoos and botanic gardens. But such efforts are expensive and limited in scope.

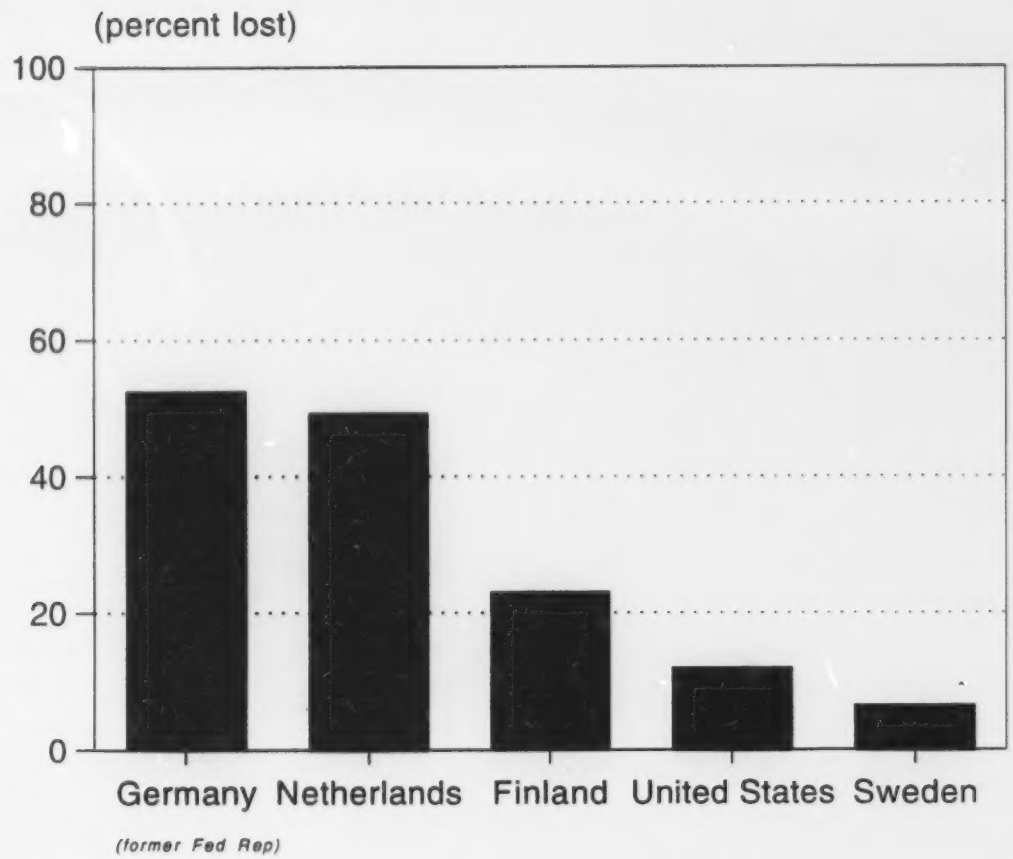
# Species Remaining to be Described




Estimated Total Species = 10 Million

**Source:** World Resources Institute, The World Conservation Union, and the United Nations Environment Programme, in consultation with the Food and Agriculture Organization and the United Nations Education, Scientific and Cultural Organization, *Global Biodiversity Strategy* (World Resources Institute, Washington, D.C., 1992), p. 156.

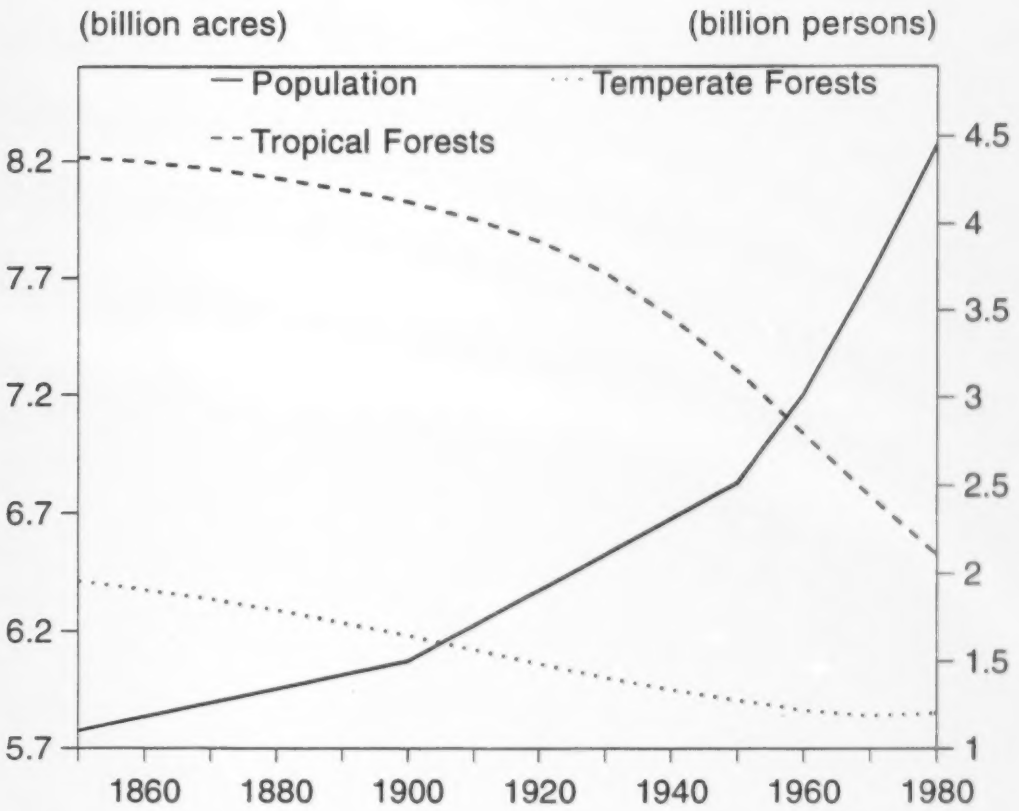
# Wetland Loss in Selected Industrialized Countries, 1950–80






**Source:** Organisation for Economic Co-operation and Development (OECD), *OECD Environmental Data Compendium 1991* (OECD, Paris, 1991), p. 75.

# Trends in Deforestation and Population Growth, 1850–1980




**Source:** World Resources Institute and The International Institute for Environment and Development, *World Resources 1987* (Basic Books, Inc., New York, 1987), Table 18.3, p. 272.

# Tropical Areas with Rich Floral Diversity

**Source:** Norman Myers, "Threatened Biotas: 'Hotspots' in Tropical Forests," *Environmentalist,* vol. 8, no. 3 (1988), pp. 1-20, and vol. 10, no. 4 (1990), pp. 243–256.

# Sources of Teaching Materials

Audubon Population Program
801 Pennsylvania Ave., SE,
Suite 301
Washington, DC 20003 USA
Phone: 202/547-9009

Bullfrog Films
Oley, PA 19547 USA
Phone: 1-800/543-FROG

Center for Marine Conservation
1725 DeSales St., NW,
Suite 500
Washington, DC 20036 USA
Phone: 202/429-5609

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Westside Station
Elmira, NY 14905 USA
Phone: 1-800/527-4264

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and Sciences
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Princeton, NJ 08543-2053 USA
Phone: 1-800/257-5126 or
609/452-1128
Fax: 609/452-1602

Friends of the United Nations
Environment Programme
(FUNEP)
2013 Q Street, NW
Washington, DC 20009 USA
Phone: 202/234-3600

Griesinger Films
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Gates Mills, OH 44044 USA
Phone: 216/423-1601

Information Services
Fisheries and Oceans Canada
Head Office—Centennial Towers
200 Kent Street
Ottawa, Ontario
K1A O16 CANADA
Phone: 613/993-0600

Minister of Environment
Jean J. Sharest
Environment Canada
Les Terrases De La Chaudiere
10 Wellington St.
Hull, Quebec
K1A OH3 CANADA
Phone: 819/997-2800

The American Forum for
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National Consortium for
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Pleasantville, NY 10570-0100 USA
Phone: 914/747-3310

Turner Broadcasting
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Environmental Program (IEEP)
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75700 Paris, FRANCE
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Washington, DC 20037 USA
Phone: 202/293-4800

World Wildlife Fund-Canada
90 Eglinton Ave., East,
Suite 504
Toronto, Ontario
MHP 227 CANADA
Phone: 416/489-8800

# Teacher's Survey
## Teacher's Guide Units

(Please use additional paper if necessary)

**1. Which *World Resources Teacher's Guide* unit did you use?**

___1. Biodiversity
___2. Car Trouble
___3. Citizen Action
___4. Energy, Atmosphere, and Climate
___5. Natural Resource Economics
___6. Oceans and Coasts
___7. Population, Poverty, and Land Degradation
___8. Sustainable Development
___9. Two Giants: China and India
___10. Watershed Pollution
___11. Women, Equity, and Sustainable Development

**2. Course(s) in which you used *World Resources Teacher's Guide* units?**

___History ___Geography ___Science
___Ecology ___Biology ___Chemistry
___Environmental Studies ___Environmental Science ___Other

**3. Which sections of the unit did you find most useful?**

___Teaching Strategies
___Student Enrichment Activities
___Student Handouts
___Overhead Transparency Masters
___Reading and AV Lists

**4. How much do you think you will use the *World Resources Teacher's Guide* units in the future?**

___Often ___Occasionally ___Rarely

**5. Did you use the Goals 2000 draft national performance standards to select material from the units?**

___Yes ___No

**6. If yes to the above question, which performance standards did you teach?**_____

_____

**7. Were the recommended activities in the unit useful in teaching those standards?**

___Yes ___No

**8. What features could be added to the *Teacher's Guide* to make it more useful to you?**

_____

_____

_____

**9. In what setting did you use the *Teacher's Guide* units?**

___Middle school
___High School
___10th grade
___11th grade
___12th grade
___Community college
___College or university
___Adult education
___Nature center
___Zoo
___Museum
___Other

**10. Was the material appropriate for your audience?**

____Yes No, because_____

**11. If you used the unit in a school, how much class time did you and your students spend on it?**

____Less than 1 class ____2–3 classes ____1–2 weeks

____1 class ____4–5 classes ____More than 2 weeks

**12. Do you regularly teach about global environmental issues?**

____Yes ____No

**13. If you don't regularly teach global environmental issues, did you find this unit offered enough information and materials to construct your lesson?**

____Yes No, I also needed_____

**14. Did you use other WRI materials with this unit?**

____Yes ____No

If yes, which ones_____

**15. Because new units of the *Teacher's Guide* are being developed, it is helpful for us to learn how the materials work. Did they engage your students? Prompt lively discussion? Help make what seemed abstract issues vivid? Please be specific with negative *or* positive comments.**

_____

_____

_____

_____

**Name**_____

**School or Organization**_____

**Address**_____

_____

**May we call you to discuss your suggestions?**

____No Yes, I can be reached at_____

**Please return to:**

**WORLD RESOURCES INSTITUTE**
ATTN: Mary Paden, Teacher's Guide
1709 New York Avenue, NW
Suite 700
Washington, D.C. 20006

**ORDER FORM**

# Environmental Teaching Materials

***From World Resources Institute***

## *World Resources 1996–97*

*A joint publication by the World Resources Institute, the United Nations Environment Programme, the United Nations Development Programme and the World Bank.*

Widely recognized as an authoritative assessment of the world's natural resource base, **World Resources 1996–97** is a definitive reference on the global environment with the latest information on essential economic, population, and natural resource conditions and trends for nearly every country in the world. Recommended as a primary reference for faculty, college, and advanced senior high students, it features a special report on environmental challenges facing the world's cities—home to 60 percent of the population by the year 2000. **World Resources 1996–97** is the primary source for *Teacher's Guide Basic Units*.

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Each self contained, loose-leaf Unit contains everything needed to teach multi-part lessons on a critical global issue including: suggestions for integrating the Unit into appropriate curriculum; step-by-step teaching instructions; student enrichment activities; and student handouts and overhead transparency masters.

***Basic Units:***

***$6.95 each or all eleven units for $49.95***

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**Car Trouble Unit** / 44 pages
**Citizen Action Unit** / 24 pages
**Energy, Atmosphere, and Climate Unit** / 27 pages
**Natural Resource Economics Unit** / 18 pages
**Oceans and Coasts Unit** / 18 pages
**Poverty, Population, & Land Degradation Unit** / 19 pages
**Sustainable Development Unit** / 34 pages
**Two Giants: China and India Unit** / 78 pages
**Watershed Pollution Unit** / 21 pages
**Women, Equity and Sustainable Development Unit** / 58 pages

## *Car Trouble*

Chronicling America's long-standing love affair with the automobile, this fascinating book sheds new light on the environmental, economic, health, and security problems posed by our car-dominated transportation system. This comprehensive analysis offers an engaging and much needed resource on contemporary transportation problems and what to do about them.

200 pages / List Price: $12.00 / **Discount Price: $9.60**

## *Preserving Our Global Environment (video)*

Viewers will see problems of population growth, biodiversity loss, and global warming documented with real-life examples in this hour-long video. Instructor guide included.

VHS 53 min. / List Price: $39.95 / **Discount Price: $31.95**

## *Introduction to Our Global Environment (video)*

This incisive, informative 10-minute video offers high school students—and teachers new to the field of environment—an excellent introduction to global change and the kinds of actions necessary to insure environmental sustainability over the long term.

VHS 10 min. / List Price: $12.95 / **Discount Price: $10.35**

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Set of 50 color slides or transparencies illustrating trends and conditions for major environmental issues. Includes instructor's guide with additional information and complete references.

*Secondary school, college, adult.*

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